

**What is claimed is:**

1           1. A protection switch in a node of a two-fiber optical channel shared protection ring,  
2 the node including a plurality of primary clients and a plurality of pre-emptible clients, each  
3 fiber in the two-fiber optical channel shared protection ring propagating at least one working  
4 wavelength channel dedicated to primary client traffic and at least one protection wavelength  
5 channel which may accommodate extra client traffic, the protection switch comprising:

6           an optical signal monitor coupled to the two-fiber optical channel shared protection  
7 ring, the optical signal monitor being operative to detect multi-wavelength channel failures  
8 and single wavelength channel failures in the two-fiber optical channel shared protection  
9 ring; and

10          an electrical switching circuit coupled to the optical signal monitor, the electrical  
11 switching circuit being comprised of a plurality of modular switching fabrics, each modular  
12 switching fabric of the plurality of modular switching fabrics including a ring switch mode  
13 that is responsive to at least one of the multi-wavelength channel failures, and a span switch  
14 mode that is responsive to at least one of the single wavelength channel failures.

1           2. The protection switch of claim 1, wherein the ring switch is operative to switch a  
2 primary client's transmission signal from a working wavelength propagating on a first fiber of  
3 the two fibers to a protection wavelength propagating on a second fiber of the two fibers,  
4 switch the primary client's receive signal from a working wavelength propagating on the  
5 second fiber to a protection wavelength propagating on the first fiber, and pre-empt the extra  
6 client traffic.

1           3. The protection switch of claim 2, wherein the multi-wavelength channel failure is a  
2 cable cut severing the first fiber and the second fiber between a first node and a second node  
3 in the ring.

1           4. The protection switch of claim 1, wherein the span switch is operative to switch a  
2 primary client's transmission signal from a working wavelength propagating on the first fiber

3 to a protection wavelength propagating on the first fiber, and switch a primary client's receive  
4 signal from a working wavelength propagating on the second fiber to a protection wavelength  
5 propagating on the second fiber.

1 5. The protection switch of claim 4, wherein the single wavelength channel failure  
2 includes an inoperative working wavelength channel.

1 6. The protection switch of claim 1, wherein each modular switching fabric includes  
2 a controller programmed to respond to the single wavelength channel failure and the  
3 multi-wavelength channel failure.

1 7. The protection switch of claim 1, wherein each modular switching fabric includes  
2 a plurality of 2 x 1 switches, and a plurality of 3 x 1 switches.

1 8. The protection switch of claim 7, wherein the plurality of 2 x 1 switches and the  
2 plurality of 3 x 1 switches are fabricated using gated semiconductor devices.

1 9. The protection switch of claim 7, wherein the plurality of 2 x 1 switches and the  
2 plurality of 3 x 1 switches are fabricated using data selectors.

1 10. The protection switch of claim 1, further comprising:  
2 a first add multiplexer coupled to the first fiber and the electrical switching circuit;  
3 a first drop multiplexer coupled to the first fiber and the electrical switching  
4 a second add multiplexer coupled to the second fiber and the electrical switching  
5 circuit; and  
6 a second drop multiplexer coupled to the second fiber and the electrical switching  
7 circuit.

1 11. The protection switch of claim 10, wherein the first add multiplexer, the first drop  
2 multiplexer, the second add multiplexer, and the second drop multiplexer operate in a range  
3 of wavelengths including 1550nm.

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1           12. The protection switch of claim 10, wherein the first add multiplexer inserts the  
2 primary client's transmission onto the first fiber using a first fiber working wavelength  
3 channel.

1           13. The protection switch of claim 10, wherein the first add multiplexer inserts the  
2 primary client's transmission onto the first fiber using a first fiber protection wavelength  
3 channel in response to a multi-wavelength channel failure.

1           14. The protection switch of claim 10, wherein the second add multiplexer inserts the  
2 primary client's transmission onto the second fiber using a second fiber working wavelength  
3 channel.

1           15. The protection switch of claim 10, wherein the second add multiplexer inserts the  
2 primary client's transmission onto the second fiber using a second fiber protection wavelength  
3 channel in response to a single wavelength channel failure.

1           16. The protection switch of claim 10, wherein the first drop multiplexer drops a first  
2 fiber working wavelength channel from the first fiber to thereby route the primary client's  
3 receive signal to the electrical switching circuit.

1           17. The protection switch of claim 10, wherein the first drop multiplexer drops a first  
2 fiber protection wavelength channel from the first fiber to thereby route the primary client's  
3 receive signal to the electrical switching circuit in response to a multi-wavelength channel  
4 failure.

1           18. The protection switch of claim 10, wherein the second drop multiplexer drops a  
2 second fiber working wavelength channel from the second fiber to thereby route the primary  
3 client's receive signal to the electrical switching circuit.

1           19. The protection switch of claim 10, wherein the second drop multiplexer drops a  
2 second fiber protection wavelength channel from the second fiber to thereby route the

3 primary client's receive signal to the electrical switching circuit in response to a single  
4 wavelength channel failure.

1 20. The protection switch of claim 10, further comprising:

2 a first optoelectric converter coupled to the first drop multiplexer and a modular  
3 switching fabric, the first optoelectric converter adapted to convert a first fiber working  
4 wavelength channel dropped from the first fiber into a first data signal readable by the  
5 modular switching fabric;

6 a second optoelectric converter coupled to the first drop multiplexer and the modular  
7 switching fabric, the second optoelectric converter adapted to convert a first fiber protection  
8 wavelength channel dropped from the first fiber into a second data signal readable by the  
9 modular switching fabric;

10 a third optoelectric converter coupled to the second drop multiplexer and the modular  
11 switching fabric, the third optoelectric converter adapted to convert a second fiber working  
12 wavelength channel dropped from the second fiber into a third data signal readable by the  
13 modular switching fabric; and

14 a fourth optoelectric converter coupled to the second drop multiplexer and the  
15 modular switching fabric, the fourth optoelectric converter adapted to convert a second fiber  
16 protection wavelength channel dropped from the second fiber into a fourth data signal  
17 readable by the modular switching fabric.

1 21. The protection switch of claim 20, wherein the modular switching fabric further  
2 comprises:

3 a first 3 x 1 switch having inputs coupled to the first optoelectric converter, second  
4 optoelectric converter, third optoelectric converter, and an output coupled to a first primary  
5 client receiver;

6 a first 2 x 1 switch having inputs coupled to the second optoelectric converter and an  
7 output coupled to a first extra client receiver;

8 a second 3 x 1 switch having inputs coupled to the second optoelectric converter, third  
9 optoelectric converter, fourth optoelectric converter, and an output coupled to a second  
10 primary client receiver;

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11 a second 2 x 1 switch having inputs coupled to the third optoelectric converter and an  
12 output coupled to a second extra client receiver; and  
13 a controller coupled to the first 2 x 1 switch, the second 3 x 1 switch, the second 2 x 1 switch,  
14 and the second 2 x 1 switch, the controller being operative to actuate the switches in response  
15 to the multi-wavelength channel failure, whereby the primary client's receive signal is  
16 received from a protection wavelength channel propagating on the first fiber instead of from a  
17 working wavelength channel propagating on the second fiber, and the extra client traffic is  
18 pre-empted.

1 22. The protection switch of claim 21, wherein the controller is operative to actuate  
2 the switches to receive the primary client's receive signal from a protection wavelength  
3 propagating on a fiber instead of a working wavelength channel on the fiber in response to  
4 the at least one fault condition being an inoperative working wavelength channel.

1 23. The protection switch of claim 10, further comprising:

2 a first electrooptic converter coupled to the first add multiplexer and a modular  
3 switching fabric, the first electrooptic converter adapted to convert a first data signal received  
4 from the modular switching fabric into a first-fiber wavelength channel to be added to first  
5 fiber traffic;

6 a second electrooptic converter coupled to the first drop multiplexer and the modular  
7 switching fabric, the second electrooptic converter adapted to convert a second data signal  
8 received from the modular switching fabric a second first-fiber wavelength channel to be  
9 added to first fiber traffic;

10 a third electrooptic converter coupled to the second drop multiplexer and the modular  
11 switching fabric, the third electrooptic converter adapted to convert a third data signal  
12 received from the modular switching fabric into a second-fiber wavelength channel to be  
13 added to second fiber traffic; and

14 a fourth electrooptic converter coupled to the second drop multiplexer and the  
15 modular switching fabric, the fourth electrooptic converter adapted to convert a fourth data  
16 signal received from the modular switching fabric into a second second-fiber wavelength  
17 channel to be added to second fiber traffic.

24. The protection switch of claim 23, wherein the modular switching fabric further comprises:

- a first 3 x 1 switch having an output coupled to the second electrooptic converter, and inputs coupled to a first primary client transmitter, a first extra client transmitter, and a second primary client transmitter;
- a first 2 x 1 switch having an input coupled to the first extra client transmitter and an output connected to the first 3 x 1 switch;
- a second 3 x 1 switch having an output coupled to the third electrooptic converter, and inputs coupled to a first primary client transmitter, a second extra client transmitter, and a second primary client transmitter;
- a second 2 x 1 switch having an input coupled to the second extra client transmitter and an output connected to the second 3 x 1 switch; and
- a controller coupled to the first 3 x 1 switch, the second 3 x 1 switch, the first 2 x 1 switch, and the second 2 x 1 switch, the controller being operative to actuate the switches in order to switch a primary client's transmission signal from a working wavelength channel propagating on a first fiber to a protection wavelength channel propagating on a second fiber in response to the multi-wavelengthchannel failure.

25. The protection switch of claim 24, wherein the controller is operative to switch a primary client's transmission signal from the working wavelength channel propagating on the first fiber to the protection wavelength channel propagating on the first fiber in response to a single wavelength channel failure.

26. The protection switch of claim 1, further comprising:

- a plurality of electrooptic converters coupled to a modular switching fabric and a plurality of client receivers, the plurality of electrooptic converters being operative to convert working data signals and extra data signals transmitted by the electrical switch circuit into 1310nm optical signals for reception by the plurality of client receivers; and
- a plurality optoelectric converters coupled to the modular switching fabric and a plurality of client transmitters, the plurality optoelectric converters being operative to convert

8 1310nm optical signals transmitted from the plurality of client transmitters into working data  
9 signals and protection data signals for use by the modular switching fabric.

1 27. The protection switch of claim 1, wherein each modular switching fabric includes  
2 an application specific integrated circuit (ASIC).

1 28. A modular switching fabric for use in a protection switch resident in a node of a  
2 two-fiber optical channel shared protection ring, each node including a plurality of primary  
3 clients and a plurality of pre-emptible clients, each fiber of the two fibers propagating at least  
4 one working wavelength channel dedicated to primary client traffic and at least one  
5 protection wavelength channel which may accommodate extra client traffic, the protection  
6 switch comprising:

7 a first 3 x 1 switch coupled to a first primary client receiver;

8 a first 2 x 1 switch coupled to a first extra client receiver;

9 a second 3 x 1 switch coupled to a second primary client receiver;

10 a second 2 x 1 switch coupled to a second extra client receiver; and

11 a controller coupled to the first 3 x 1 switch, the second 3 x 1 switch, the first 2 x 1  
12 switch, and the second 2 x 1 switch, the controller being operative to actuate the switches in  
13 order to receive the primary client's receive signal from a protection wavelength propagating  
14 on the first fiber instead of a working wavelength channel propagating on the second fiber,  
15 and pre-empt extra client traffic, in response to a multi-wavelength channel failure.

1 29. The two-fiber optical channel shared protection ring of claim 26, wherein the  
2 controller is operative to actuate the switches to receive the primary client's receive signal  
3 from a protection wavelength propagating on a fiber instead of a working wavelength channel  
4 on the fiber in response a single wavelength channel failure.

1 30. A two-fiber optical channel shared protection ring for bi-directional  
2 communications between a plurality of nodes, each node including a plurality of primary  
3 clients and a plurality of pre-emptible clients, each fiber of the two fibers propagating at least  
4 one working wavelength channel dedicated to primary client traffic and at least one

5 protection wavelength channel which may accommodate extra client traffic, the protection  
6 switch comprising:

7 a first 3 x 1 switch having inputs coupled to a first primary client transmitter, a first  
8 extra client transmitter, and a second primary client transmitter;

9 a first 2 x 1 switch having an input coupled to the first extra client transmitter and an  
10 output connected to the first 3 x 1 switch;

11 a second 3 x 1 switch having inputs coupled to a first primary client transmitter, a  
12 second extra client transmitter, and a second primary client transmitter;

13 a second 2 x 1 switch having an input coupled to the second extra client transmitter  
14 and an output connected to the second 3 x 1 switch; and

15 a controller coupled to the first 3 x 1 switch, the second 3 x 1 switch, the first 2 x 1  
16 switch, and the second 2 x 1 switch, the controller being operative to actuate the switches in  
17 order to switch a primary client's transmission signal from a working wavelength propagating  
18 on a first fiber of the two fibers to a protection wavelength propagating on a second fiber of  
19 the two fibers in response to a multi-wavelength channel failure.

1 31. The protection switch of claim 30, wherein the controller is operative to switch a  
2 primary client's transmission signal from the working wavelength propagating on the first  
3 fiber to the protection wavelength propagating on the first fiber in response to a single  
4 wavelength channel failure.

1 32. A method for switching bi-directional traffic between a plurality of nodes in a  
2 two-fiber optical channel shared protection ring, each node including a plurality of primary  
3 clients and a plurality of pre-emptible clients, each fiber of the two fibers propagating at least  
4 one working wavelength channel dedicated to primary client traffic and at least one  
5 protection wavelength channel which may accommodate extra client traffic, the method  
6 comprising:

7 providing a protection switch in each node of the plurality of nodes, each protection  
8 switch being coupled to the two fibers, the plurality of primary clients, and the plurality of  
9 pre-emptible clients, wherein the protection switch includes a plurality of modular switching  
10 fabrics;



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11 detecting a fault condition in the two-fiber optical channel shared protection ring;  
12 actuating at least one of the modular switching fabrics in response to the step of  
13 detecting, whereby a primary client's transmission signal is switched from a working  
14 wavelength propagating on a first fiber of the two fibers to a protection wavelength  
15 propagating on a second fiber of the two fibers, switching the primary client's receive signal  
16 from a working wavelength propagating on the second fiber to a protection wavelength  
17 propagating on the first fiber, and pre-empting extra client traffic.

1 33. The method of claim 32, wherein the fault condition is a  
2 multi-wavelengthchannel failure.

1 34. The method of claim 32, wherein the step of actuating includes switching a  
2 primary client's transmission signal from the working wavelength propagating on the first  
3 fiber to the protection wavelength propagating on the first fiber, and switching the primary  
4 client's receive signal from a working wavelength propagating on the second fiber to a  
5 protection wavelength propagating on the second fiber.

1 35. The method of claim 34, wherein the fault is a single wavelength channel failure.